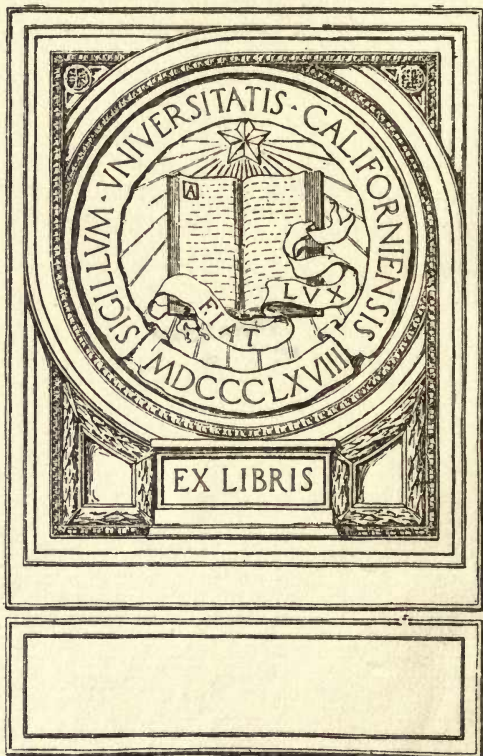


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WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF
AGRICULTURE

H. L. Russell, Dean.

BULLETIN NO. 54D .

SOIL SERIES NO. 26

SOIL SURVEY
OF
OUTAGAMIE COUNTY
WISCONSIN

BY

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UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
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INTRODUCTION

Before the greatest success in agriculture can be reached it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering

suggestions for their management, based upon the work of the Soil Survey within the area covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water-holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture as long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater

proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

SOILS CONTAINING LESS THAN 20% SILT AND CLAY

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

SOILS CONTAINING BETWEEN 20-50% OF SILT AND CLAY

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

SOILS CONTAINING OVER 50% OF SILT AND CLAY

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and over 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. As the soils of this series have been

derived largely from sandstone, the types are mostly of a sandy nature. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF OUTAGAMIE COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Outagamie County is located in the east-central part of Wisconsin, and covers an area of 646 square miles, or 413,440 acres.

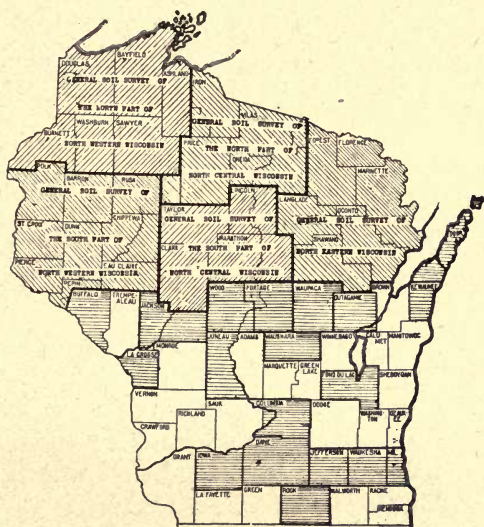


Figure 1.—Sketch map showing progress of the soil survey.

Viewed from an agricultural standpoint, Outagamie County ranks with the foremost of the state. Over 80 per cent of the total area is in farms, and more than two-thirds of this is improved land. Several rather large areas of marsh occur in the north-western part of the county. Lying between the Embarrass, Wolf and Shioe Rivers is a broad, flat stretch of fairly fertile soil, which was principally laid down by these streams during seasons of high water. This area covers most of the townships of Deer Creek, Maple Creek, Liberty and the west part of Cicero.

In the townships of Liberty and Hortonville, and between Hortonville and Stephenville, numerous hills and ridges of fine sand occur. Similar hills are also found in the northern part of the town of Maine.

South and east of the low flat plains mentioned above is the most important farming section of the county. It consists of the rolling, fertile Superior soils. The highly improved condition of the farms, the excellent farm buildings and the modern school houses and churches all point to these soils as being among the most productive of the region. The remainder of the county to the southeast is principally occupied by the level, heavy, Superior soils. In fertility and productiveness, they rank close to the rolling Superior, but on account of their low flat character they are usually deficient in drainage.

The northern and western portions of Outagamie County are drained through the Wolf River and its tributaries into Lake Michigan.

The Wolf, the Embarrass and the Shioc Rivers draining the north-western part of the area are all slow, meandering, sluggish streams within this area, and a great deal of the low, flat surrounding territory is subject to overflow in the spring of the year. The streams in the eastern and southern parts of the county have a larger amount of fall. The Fox River in a distance of thirty-five miles, has a difference in elevation of 170 feet. The excellent water power facilities offered by this stream have been highly developed and have made this region famous as a paper and pulp producing center.

The first white man to settle in the county was probably Dominique Ducharme, who established himself in 1790 near the present site of Kaukauna. In 1851, Outagamie County was formed from Brown County.

Over Outagamie County the population is quite evenly distributed. The township of Maine is most thinly settled, and the region directly bordering the Fox River is the most thickly settled. The census of 1920 reports the population of the county as 55,113. This gives an average of 85.3 persons per square mile.

Outagamie County is well supplied with railroad facilities. The wagon roads through the county are generally in fair condition. A system of concrete roads is now under construction, which when completed will connect all of the principal towns in the county.

The towns within the area afford a market for much of the farm produce, but the greater part is shipped to outside points. Of the agricultural output, dairy products are most important. Butter and cheese are shipped to all parts of the country. Several milk condenseries are located within the county. Livestock of all kinds are shipped from towns in the area. Excellent markets are within easy access of all farms.

ONEIDA INDIAN RESERVATION.

The Oneida Indian Reservation is located in the north-east corner of Outagamie County. The entire reservation consists of over 60,000 acres of land, but nearly half of this is in Brown County.

In 1824 about eighty Oneida Indians coming from the state of New York purchased land of the Menominee Indians along Duck Creek within the present boundaries of the reservation. More of the same nation continued to come, and by 1838 the colony numbered about 650. In this year the United States Government made its first treaty with them, setting aside one hundred acres of land for each individual. The Indians, as a rule, have done little to improve the land within the reservation, although a few have cleared farms and built homes.

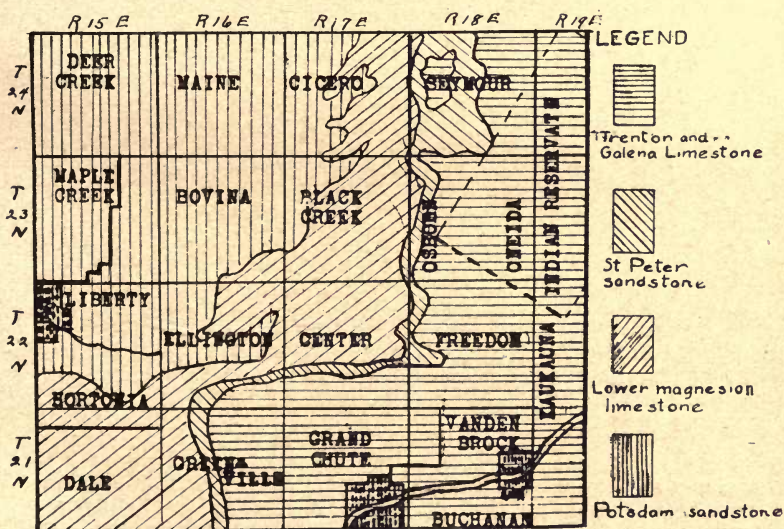


Figure 2.—Sketch map of Outagamie County, showing the underlying rock formations, from which the soil has in part been derived.

During the past few years most of the Indians have been given a clear title to their lands, with the privilege to sell or dispose of the same, and, due to this fact, white settlers and land companies are rapidly getting control of a larger part of the area, and are clearing and improving much of the excellent land which has heretofore lain idle.

Near Oneida Station, within the reservation, the Government maintains a free school with a farm where the Indian children may be sent for nine months of the year with no expense whatever to the parents. District schools are also maintained throughout the area, and several churches have been erected. The bulk of the population is in the southern part of the reservation, the thickest settlements being along the banks of Duck Creek. The northern part is very thinly settled.

SOILS.*

Outagamie County, in common with the greater part of eastern and northern Wisconsin, owes the general character of its surface material to several distinct methods of accumulation. These materials may be of glacial, alluvial or lacustrine (deposited in lakes) origin. In addition to these agencies may be added the accumulation of organic matter in low places which has resulted in the formation of large areas of peat soils. In a

*In comparing this issue of the soil survey report of Outagamie County with the edition published by the United States Bureau of Soils it will be noted there is some difference in the naming of some of the soil types. In the State report the types have been correlated with the soils as previously mapped within the State while in the report issued by the United States Bureau of Soils the types have been correlated with the soils as they occur in adjoining States. The following table gives the various soils to which different names have been applied in the two reports.

Soil Type Names as used by U. S. Bureau of Soils	Soil Type Names as used in the report issued by the State of Wisconsin.
Clyde fine sandy loam—till phase	Clyde fine sandy loam
Clyde silt loam—till phase.....	Clyde silt loam
Coloma very fine sand.....	Coloma fine sand
Genesee very fine sandy loam.....	Genesee fine sandy loam
Kewaunee fine sandy loam.....	Superior fine sandy loam— rolling phase
Kewaunee loam.....	Superior loam, rolling phase
Kewaunee silt loam.....	Superior silt loam, rolling phase
Kewaunee clay loam.....	Superior clay loam, rolling phase
Merrimac very fine sandy loam.....	Antigo fine sandy loam
Merrimac loam.....	Antigo loam
Plainfield very fine sand.....	Plainfield fine sand

geological classification which takes into consideration the underlying rock formations the county naturally falls into several divisions.

The bed rock underlying the soils of Outagamie County consists of two radically different formations, sandstone and limestone. There are two ages of sandstone and two ages of limestone. The accompanying sketch map shows the approximate location and extent of the four rock formations which make up the surface rock of this region. These are the Potsdam sandstone, lower magnesian limestone, St. Peter's sandstone and Trenton and Galena limestone.

All of these formations have contributed to some extent to the soils of the region. In addition the glacier carried quantities of the granitic material over onto the other rock formations. The granitic boulders frequently seen are an evidence of this action.

Another formation within the county is represented by the heavy red clay. This red material was deposited in quiet waters when the Great Lakes stood at a much higher level than at present. After being deposited, this material was acted upon by the ice sheet and was mixed to some extent with other materials. The surface in places was left level, as along the Fox River, and rolling as in the Town of Dale and elsewhere.

As a result of the various geological agencies which have influenced this region, the surface of the county falls into three rather distinct divisions.

The northwestern quarter of the county consists of an extensive alluvial plain in which the soils have been deposited by flood waters from the Wolf, Shioc and Embarrass Rivers. These streams traverse regions of both sandstone and crystalline rocks and the alluvial soils are therefore a mixture of materials from both these sources. Within this region there are extensive marsh areas, consisting for the most part of peat.

In the southeastern part of the county there is a considerable area along the Fox River where the soil is a heavy red clay, and where the surface is level, it having been influenced to only a limited extent by glacial action since its deposition.

Between this region and the one described as covering the northwestern quarter of the county, there is another region much larger than either of the other two, in which is found

the best agricultural land within the area. It is a rolling country in which the subsoils are largely made up of red clay which has been mixed by glacial action with glacial material from both sandstone and limestone formations.

In the survey of Outagamie County, these various materials have been classified into ten soil series and nineteen soil types. The soil series (which correspond to the family group) are described here only very briefly. The individual soil types are fully described and are shown on the map, each being indicated by a distinct color. It is the soil types in which we are especially interested since the type is the unit in mapping and classifying soils. Following is a complete list of the soil types mapped in the county, and the series or family group to which each type belongs.

The Superior series is characterized by the heavy red clay which forms the subsoil of all the types within this series. Typically the surface is level or nearly so, and the natural surface drainage is somewhat deficient. Where this same material occurs and the surface is sufficiently rolling to insure fair to good surface drainage, the term *rolling phase* is used to describe it. In this county the rolling phase of the various types is more extensive than the typical soil. The types mapped are the Superior clay loam, silt loam, loam, and fine sandy loam. With each of these types a rolling phase was also mapped.

The Poygan series includes dark colored, low-lying, poorly drained soils underlain by heavy red clays. The types mapped in this area are Poygan clay loam, silt loam, and fine sandy loam.

The Coloma series includes light-colored upland soils which have been derived chiefly from glaciated sandstone. The types mapped are Coloma fine sandy loam and fine sand.

The Antigo series includes light-colored soils which occur as level tracts known as outwash plains or stream terraces. These soils have been derived chiefly from glaciated granitic material and to a lesser extent from sandstone material, all of which has been re-deposited by running waters. The types mapped here are Antigo loam and fine sandy loam.

The plainfield series is similar to the Antigo except that the material forming it has been derived largely from sandstone instead of from granite rocks. The Plainfield fine sand is the only type of the series mapped in this county.

The Miami series consists of light-colored upland soils which were originally timbered and which consist of glacial material derived in part from limestone. The types mapped in this county are the Miami loam and fine sandy loam.

The Whitman series consists of low-lying, poorly drained, dark-colored soils which occur within stream valleys as plains or depressions in the upland where the material has come largely from glaciated granitic regions and where the soils are in an acid condition. The types mapped are the Whitman loam and the Whitman fine sandy loam.

The Clyde series consists of low-lying, poorly drained, dark-colored soils occupying stream valleys, old lake beds or ponded valleys where the soil material has come largely from limestone. It is very similar to the Whitman series except that it contains a considerable amount of lime carbonate and is very seldom in an acid condition. The types mapped were Clyde silt loam and fine sandy loam.

The Dunning series includes dark-colored, light-textured, poorly drained soils, where the parent material for the most part is sandstone. The soils of this series are acid. The types mapped are Dunning loam and fine sandy loam.

The Genesee series consists of brown or light brown soils which occur as first bottom land. In this area they are of very limited extent and of minor importance. Two types, silt loam and fine sandy loam, were mapped.

In addition to these various soils, there are extensive areas mapped as peat. This consists of decaying organic matter, with which there has been incorporated a very small amount of fine earth.

In the subsequent pages of this report, the various soil types mapped in Outagamie County are discussed in detail.

The distribution of the various soils is shown on the map, and the actual and relative extent of each is shown in the following table.

AREA OF DIFFERENT SOILS.

Soil	Acres	Per Cent
Superior loam.....	23,488	
Superior loam rolling phase.....	62,656	20.9
Peat.....	51,264	
Shallow phase.....	8,704	14.5
Superior fine sandy loam.....	7,808	
Superior fine sandy loam rolling phase.....	49,984	14.0
Superior clay loam.....	28,032	
Superior clay loam rolling phase.....	22,528	12.3
Superior silt loam.....	22,528	
Superior silt loam rolling phase.....	26,368	11.8
Poygan silt loam.....	17,216	4.2
Antigo fine sandy loam.....	16,512	4.0
Coloma fine sand.....	15,488	3.7
Antigo loam.....	12,928	3.1
Genesee silt loam.....	12,672	3.1
Whitman fine sandy loam.....	9,792	2.4
Whitman loam.....	5,888	1.4
Miami fine sandy loam.....	5,184	1.3
Poygan clay loam.....	4,852	1.0
Plainfield fine sand.....	2,560	.6
Genesee fine sandy loam.....	2,176	.5
Clyde silt loam.....	1,728	.4
Coloma fine sandy loam.....	1,152	.3
Poygan fine sandy loam.....	960	.2
Clyde fine sandy loam.....	832	.2
Miami loam.....	576	.1
	413,440	

CHAPTER II.

GROUP OF HEAVY SOILS.

SUPERIOR SILT LOAM.

Extent and distribution.—This soil occupies a total area of about one township. Irregular tracts ranging in size from a few acres to five or six square miles extend across the eastern part of the county in a northeasternly and southwesternly direction. It occurs more extensively in T 24 N, R 19 E in the towns of Osborn, Freedom, Grand Chute, and Center. There are only a very few small patches in the west half of the county.

Description.—The surface soil of this type to a depth of about eight inches consists of a brown silt loam containing a considerable amount of organic matter. The surface soil is free from gravel and stones. The subsoil consists of a heavy compact pinkish red clay, which extends to a depth of over three feet.

There are some variations in this soil, the chief one being the depth of the silty material over the heavy red clay subsoil. This may vary from four to five inches up to ten or twelve inches. There is also some variation in the amount of organic matter, the largest amount being found in areas which are slightly depressed. Aside from these variations, which are all of minor importance, the type is very uniform.

Topography and drainage.—The surface of the Superior silt loam is level, or only very gently undulating, and because of the heavy character of the subsoil, natural drainage is somewhat deficient. During spring, when heavy rains are common, the soil becomes saturated, hence it warms up more slowly than soils having a more rolling surface. Over a considerable part of this type tile drains could be installed to good advantage.

Origin.—The material forming this soil has been derived largely from lacustrine (lake laid) material which was deposited in quiet waters at a time when the Great Lakes stood

at a much higher level than at the present time. After this first deposition it was modified to some extent by glacial action.

Native vegetation.—The original timber growth consisted chiefly of maple, birch, elm, some beech, and pine. Practically all of the merchantable timber has been removed. Most of this soil has been cleared, and is now in highly improved farms. About the only exception to this is in the extreme northeast corner of the county in T 24 N, R 19 E where the land was until very recently a part of the Indian Reservation.

*Present agricultural development.**—The chief crops grown consist of hay, small grains, corn, and root crops. It is naturally a strong productive soil; when drainage is provided, very good yields are secured. On practically all of the farms made up of this soil, there is some land which is too wet for the growing of cultivated crops without supplying some form of drainage. When thoroughly drained, this soil will rank along with the best in the county. It is somewhat more difficult to cultivate than soils of lighter texture, but if plowed when moisture conditions are favorable, a good seed bed can be secured with but little difficulty.

SUPERIOR SILT LOAM.

ROLLING PHASE.

Extent and distribution.—This soil covers a total area of approximately one township, and is the predominating type in the town of Greenville. It is also quite extensive in the town of Grand Chute, and there are numerous small tracts in the south-east part of the county.

Description.—The surface soil to a depth of about eight inches consists of a brown to dark brown rather compact silt loam containing a moderate amount of organic matter. It is practically free from gravel and stones are seldom found upon it. The subsoil into which the surface material grades quite abruptly consists of the heavy red clay which is characteristic of this series.

Topography and drainage.—The surface of this soil varies from undulating to gently rolling, and in some instances it could be classed as rolling. On account of the surface features the

*For chemical composition and improvement of this soil, see page 23.



VIEW SHOWING TYPICAL LEVEL TO GENTLY UNDULATING SURFACE FEATURES OF THE SUPERIOR SOILS.

Where the soils of this series are heavy the natural drainage is somewhat Deficient.



VIEW OF SUPERIOR CLAY LOAM, ROLLING PHASE.

The term "rolling phase" is used where the surface is sufficiently rolling to insure fair to good natural drainage.

natural surface drainage is usually good, although the heavy compact subsoil does not permit the water to move freely through it. On some of the more gently sloping portions of the type, and in depressions between hills lines of tile could be installed to good advantage.

Origin.—This soil has been derived largely from lacustrine material which has been influenced to a considerable extent since its first deposition by the action of ice.

While the surface soil is sometimes found to be slightly acid, the subsoil usually contains a considerable amount of lime carbonate.

Native vegetation.—The original forest growth consisted chiefly of maple, birch, basswood, hickory, with some beech, elm, hemlock, and pine.

*Present agricultural development**—This is one of the desirable soils of the county, and one upon which agriculture is very highly developed. It is a strong productive soil, and well adapted to the general farm crops common to this region. Small grains and grasses do especially well, and the dairy industry is the most important line of farming followed.

The rotation most commonly followed consists of small grain, followed by clover, or clover and timothy, followed by corn.

This soil is not so difficult to cultivate as is the clay loam, but nevertheless, it requires heavy working stock and tools.

SUPERIOR CLAY LOAM.

Extent and distribution.—Superior clay loam is found chiefly in the towns of Kaukauna, the southeastern part of Freedom, Vandenbroek, and Grand Chute. The total area is approximately one township.

Description.—The surface of the clay loam to an average depth of six inches consists of a light grayish-brown clay loam which grades quite abruptly into the heavy compact red clay which extends to an undetermined depth. The light-colored material over the red clay varies somewhat in depth from one or two inches to seven or eight inches. In the heavy clay subsoil, especially, in the lower depth, it is not uncommon to find thin seams of fine and very fine sand. It is also common to find in the soil section a small amount of very fine rock fragments largely of limestone.

*For chemical composition and improvement of this soil, see page 23.

The texture of both the soil and subsoil of this type is very uniform.

Topography and drainage.—The surface of this soil is level or only very gently undulating, and the natural drainage is deficient. During the early spring, portions of the type are frequently covered with an inch or so of water. Because of the heavy subsoil and the slowness with which water moves through it, the type remains wet and cold for some time during the early part of each growing season, and the planting of crops is frequently delayed on this account. Practically all of this soil could be improved by tile drainage although up to the present time but very few have been installed.

Present agricultural development.—Practically all of the crops common to the region are grown with success upon this soil, but it is better adapted to small grains and grasses than to corn. Where drainage has been supplied, corn can be grown successfully, and all the other crops are much more certain of giving satisfactory yields. Tile drainage permits the soil to warm up much earlier in the spring which gives the crops a better start.

SUPERIOR CLAY LOAM, ROLLING PHASE.

Extent and distribution.—This soil is chiefly found in the southeast portion of the county, and is the predominating type in the towns of Vandenbroek and Buchanan. Small patches are found in the towns of Grand Chute, Greenville, Center, and Black Creek.

Description.—The surface of this soil to a depth of three to four inches is a compact silt loam, or silty clay loam, of a brown or slightly reddish-brown color. This material grades abruptly into a heavy compact pinkish red clay subsoil. This heavy material extends to a great depth and some of the road cuts and stream channels show it to extend to a depth of forty to fifty feet. The surface of the type is practically free from stones and only a very small amount of gravel is ever found upon it. In the soil section, a very few small limestone fragments or concretions are sometimes found.

Topography and drainage.—The surface varies from undulating to rolling. In a few instances in Buchanan township the

*For chemical composition and improvement of this soil, see page 22.

surface is quite broken. Because of the uneven character of most of this soil the surface drainage is good. The compact subsoil, however, does not permit the water to move freely within the soil. The only difference between this soil and the typical Superior clay loam is the difference in topography.

*Present agricultural development.**—Practically all of the merchantable timber has been removed, and very nearly all of the type is now cultivated. This is an excellent soil, well adapted to general farming and dairying, and all of the farm crops common to the region are successfully grown upon it. A rotation quite commonly practiced consists of small grain one or two years, followed by clover or a mixture of clover and timothy for one or two years, and then followed by corn.

About the only fertilizer used is stable manure, but since the soil is very heavy and somewhat deficient in organic matter, a practice which is good, but not common, is to supplement the stable manure by plowing under a green manuring crop about once in four or five years, and for this purpose legumes are best.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SUPERIOR SILT LOAM AND SUPERIOR CLAY LOAM.

These soils are similar in the texture and structure of the subsoil section. They differ chiefly in topography and texture of the surface soil, as indicated by the type names. The types are so closely related that methods for the improvement of one will apply to the others.

The four elements with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient, are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant, and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years, and has lost some of the lime carbonate which it contained. Varying degrees of acidity have developed over the region. The loss of lime (calcium carbonate) from the soil is caused by two distinct factors, both of which are important. Crops require lime in their growth. A five-ton crop of alfalfa requires 185

pounds of lime and two tons of red clover requires 61.6 pounds. A much larger amount is removed by leaching each year and these losses must be made up by the application of lime in order to maintain the fertility of this soil.

Tests show that the subsoil is usually well supplied with lime and that the deficiency is confined largely to the surface soils.

While it will be seen from tests that part of this land shows some degrees of acidity it does not mean that all of this land is in immediate need of lime. Where such crops as alfalfa, sugar beets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium two tons per acre of ground limestone may be used with profit. Where a liberal supply of manure is available the need for lime will not be so great.

Where such crops as corn, clover and oats are grown with manure applied once during each rotation a smaller amount of lime will be needed. On parts of the farm where manure cannot be applied the lime can be used with profit on such soils and may be actually necessary for economic production. The greater need will usually be on the higher places, rather than on the lower slopes.

It has been quite definitely established that the need for lime in acid soils runs practically parallel with the need of phosphorus. The use of lime alone will not make enough phosphorus available, and the use of a phosphate fertilizer will not supply the lime requirements of the soil. Either lime alone or acid phosphate alone will give increased yields, but neither alone will give as great an increase nor as profitable an increase as when both are supplied. In the improvement of acid soils, therefore, provisions for the use of both lime and a phosphate fertilizer should be made.

Phosphorus exists in all soils in Wisconsin in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. This element cannot be supplied from the air and in

the long run the loss must be made up through additions of phosphorus fertilizer in some form.

The chemical analyses of the Superior silt loam and clay loam soils show that their phosphorus content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is larger. Their content of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections the soil being acid, while in others they contain as high as ten to twelve per cent of lime carbonate. It should be borne in mind that where soils are acid the amount of phosphorus which they do contain is not so readily available to plants as in soils which are not acid.

On good upland soil where dairying or general farming is practiced the use of 300 pounds of 16% acid phosphate or 100 pounds of 44% superphosphate to the acre every four years will maintain the phosphorus supply. If much grain, potatoes or other crops are sold, about double these amounts should be used.

On soils relatively low in fertility somewhat more phosphate should be used at first. This is especially true of the soils which have grown corn or small grain a long time without the use of manure or other fertilizer.

If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cottonseed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers follow this practice, some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts. They often contain over 50,000 pounds of this element per acre to a depth of eight inches, while they contain only 1-20 as much phosphorus. This potassium, however, in the form in which it exists in the soil is not readily available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where

crops using unusually large amounts of available potassium are grown that fertilizers containing this element need be used.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental to some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen the nitrogen supply is gradually exhausted and the yields are reduced.

Nitrogen exists in the soil almost entirely in combination with organic or vegetable matter. In the light colored soils the vegetable matter is relatively low and should be increased. The accumulation of organic matter high in nitrogen is most readily brought about through the growth of legumes such as clover, alfalfa or soy beans. These may either be turned under as green manuring crops in which case all of the nitrogen collected from the atmosphere is returned to the soil and made available to succeeding crops, or they may be fed to animals and the manure returned to the soil so that a portion at least of the nitrogen gathered from the atmosphere is returned to the land to add to the supply already there. Whatever system of farming is followed on these soils should include a rotation one member of which is a legume.

Certain crops such as potatoes and vegetables are frequently grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. In such cases fertilizers containing nitrogen and potash, as well as phosphorus may be used. Mixed fertilizers are, therefore, manufactured and offered for sale. The composition of these fertilizers is indicated by a formula. A 2-10-4 fertilizer, for instance, is one containing 2% of ammonia, or nearly 2% of nitrogen, 10% of phosphoric acid and 4% of potash.

When nitrogen and potash are needed as well as phosphoric acid, there is some advantage in using these mixed fertilizers. But when the farmer needs to use only a phosphate fertilizer, purchasing a mixed fertilizer means that he is buying not only

nitrogen and potash which he does not need, but he is compelled to pay a considerably higher price for the phosphate he gets than is the case when he buys a fertilizer containing phosphate only. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizer, in addition to manure. The following table gives the results of some of these experiments.

Crop	Ten tons manure only	Ten tons manure and 1,000 lbs. rock phosphate	Percent of increase
Potatoes-----	87 bu. per A.	123 bu.	47
Rutabagas-----	108 bu. per A.	137 bu.	27
Corn-----	30.4 bu. per A.	36.8 bu.	21
Clover hay-----	2,223 pounds	3,177 pounds	43
Clover seed-----	217.5 pounds	336.7 pounds	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Phosphorus may also be supplied as acid phosphate in which form it is immediately available to plants. In the form of rock phosphate the phosphorus becomes available slowly.

Where the surface of the heavy soil is level, as is frequently the case, the question of drainage is one of importance. Over practically all such level areas tile drains could be installed to advantage. Thorough drainage will make these soils warm up earlier in the spring, insure better tilth and increase yields.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS.

SUPERIOR LOAM.

Extent and distribution.—The Superior loam occupies a total area of approximately one township. It is found most extensively in the northern half of T 24 N, R 19 E in the towns of Seymour, Osborn, Freedom.

Description.—The surface soil of this type to a depth of about ten inches consists of a dark brown friable loam which contains a moderate amount of organic matter. This type is also free from stones and contains but very little gravel. The subsoil below ten inches grades abruptly into the heavy compact red clay which is characteristic of this series. This bed of clay extends to an undetermined depth, probably forty to fifty feet at least.

Topography and drainage.—The surface of this type, as is characteristic of this series, is level or only very gently undulating, and because of the level surface and heavy subsoil the natural drainage is somewhat deficient. These are associated with this soil a large number of areas of soils belonging to the Poygan series which occupy poorly drained depressions.

A large part of the Superior loam would be benefited by tile drainage, although up to the present time, but few tile drains have been installed.

*Present agricultural development**—Most of this soil has been cleared and placed under cultivation, and is now in highly improved farms. About the only exception to this of any note is in the northern part of T 24 N, R 19 E where a portion of this soil was included in the Indian Reservation. Practically all of the general farm crops common to this region are grown upon this type. It is a good general farming soil, especially adapted to small grains and grasses. The dairy industry has been developed to a considerable extent upon it.

*For chemical composition and improvement of this soil, see page 36.

SUPERIOR LOAM, ROLLING PHASE.

Extent and distribution.—This is one of the most important and extensive types of soil in Outagamie County. It is confined chiefly to the eastern half of the county, and is the predominating type in the towns of Seymour, Osborn, Freedom, and Center. Small tracts of this soil are found in every town of the county with the exception of Maine and Deer Creek.

Description.—The surface soil to an average depth of about ten inches consists of a brown mellow loam. It contains only a moderate amount of organic matter. The subsoil which extends to an undetermined depth consists of the heavy compact red clay which is so common in this region. There are very few stones on this soil—in fact, it may be said to be stone-free, and it is very seldom that gravel is found either on the soil or in the soil section. In a few instances, small knolls are found upon the surface of which there is a small amount of gravel.

Topography and drainage.—The surface of this soil ranges from undulating to gently rolling and the natural surface drainage is, for the most part, good. Where the phase borders typical Superior soils and the slope is only moderate, the drainage is sometimes slightly deficient. This is also true of some depressions and some of the land along streams. In such places, a line of tile could frequently be installed to good advantage.

*Present agricultural development**—This is one of the most important and highly improved soils of Outagamie County, and many of the finest farms in the region are located upon it. Almost every acre is tillable. All of the farm crops common to the region are successfully grown, and the yields are somewhat higher than on the clay loam soils. This is partly due to the fact that the soil can be worked under a somewhat wider range of moisture conditions, and can be placed in better tilth at a somewhat earlier date in the season. General farming or dairying are the chief types of farming found.

The rotation most commonly practiced consists of small grain, followed by clover, or clover and timothy, followed by corn. The only fertilizer used on this soil to any extent is stable manure. In addition to this, the plowing under of a green manuring crop is now receiving some attention. Commercial fertilizers

*For chemical composition and improvement of this soil, see page 36.

are not used to any extent, but tests made elsewhere indicate that this soil will respond with profit to the use of phosphate fertilizers.

SUPERIOR FINE SANDY LOAM.

The surface soil of this type to a depth of from eight to ten inches consists of a loose friable loam, or fine sandy loam of a dark brown color. It usually becomes somewhat lighter in color and coarser in texture to a depth of from twelve to twenty inches where the heavy red clay characteristic to this series is found. This heavy subsoil frequently contains thin seams of fine and very fine sand, and in places it is also common to find a very small amount of limestone fragments through it. The depth of the heavy subsoil is somewhat variable ranging from eight to twenty-four inches.

This soil is of limited extent, and most of the areas, all of which are small, are scattered through the towns of Center, Freedom, Kaukauna, Greenville and Grand Chute.

The surface of this soil is level, with only a very few undulations. The natural drainage is somewhat deficient because of the heavy subsoil, but is somewhat better than the drainage of the heavier types of this series. Tile drains could be profitably installed over a considerable proportion of this type, however. The original timber growth consisted largely of maple birch, with a small amount of elm, some hemlock, and pine.

The greater part of this soil has been cleared, and placed under cultivation, and the farm crops common to the region are being grown successfully upon it. Because of its limited extent, there are but few, if any, farms located entirely upon this soil.

In the improvement of Superior fine sandy loam, drainage is a factor which must be considered in many cases, but in some instances tile drains are not necessary.

The supplying of additional organic matter should be considered, however, and the plowing under of a legume crop will greatly assist in this direction.*

*For chemical composition and improvement of this soil, see page 36.



SHOWING SURFACE FEATURES OF SUPERIOR FINE SANDY LOAM,
ROLLING PHASE.

This is excellent soil, and one of the extensive types in the county.



SHOWING SAND BLOWN INTO LOW DUNES BY THE WIND.

This condition is not extensive in Outagamie County. This poor sandy soil shows a very marked contrast to the highly improved land immediately adjacent to it.

SUPERIOR FINE SANDY LOAM.

ROLLING PHASE.

Extent and distribution.—This soil is the most widely distributed type, being found in every town in the county. It is most extensively found in the southwestern quarter of the county, and predominates in the towns of Dale, the western part of Horton, and Maple Creek.

Description.—The surface soil to an average depth of eight inches is a brown to a rather dark brown mellow fine sandy loam. Immediately below this depth the color becomes somewhat lighter, frequently being a pale yellow. At about eighteen inches, heavy compact red clay is encountered. This continues to a depth which is undetermined, but which is always much more than three feet. The chief variation in this soil is in the depth of the sandy material over the red clay. This may range from eight to about twenty-four inches. There is also some variation in the texture of the surface material, there being a few places which could be classed as sandy loam, and again where it approaches a loam in texture. Such variations are too limited to be indicated, however.

While stones are not common on this soil, a few limestone boulders were found. Wherever they occur in sufficient numbers to interfere to any extent with farming operations, appropriate symbols have been placed upon the soil map. In the soil section and chiefly in the second and third foot below the surface, fragments of partially decomposed limestone may sometimes be found.

Topography and drainage.—The surface of this soil ranges from undulating to rolling, and the natural drainage is good. The drainage is much better on this soil than on the silt and clay loam types.

Present agricultural development.—While there are still a few wood lots on this soil, by far the greater part of it has been cleared, placed under cultivation, and is now in highly improved farms. In fact, where this soil predominates, is found to be some of the most highly improved and prosperous farming communities in the county. All of the general crops common to the region are grown successfully. Potatoes are also grown more commonly on this soil than on the heavier types of the region. Alfalfa is also a crop which does well, and which is being grown

to a larger extent every year. This soil is adapted to a somewhat wider range of crops than the heavier soils, and is more desirable because it can be worked under a wider range of moisture conditions. Its sandy surface permits it to drain out and warm up earlier in the season; so crops on this soil will frequently have a week or ten days and sometimes even more advantage over crops grown on the heavy, and especially, heavy and level soils.*

MIAMI LOAM.

The surface soil of this type consists of a brown or dark brown friable mellow loam extending to a depth of about eight inches. The subsoil usually consists of a fine sandy loam carrying a small amount of fine gravel. The underlying rock is frequently found at a depth of from fifteen to thirty inches, and frequently immediately above the rock there is a layer of heavy somewhat reddish material which is probably residual from limestone. This soil is quite variable, ranging from a silt loam to a fine sandy loam which is inclined in places to be somewhat gravelly. The subsoil is also variable, ranging from a sandy loam to a loam or even a clay loam. This type is of very limited extent and of minor importance. It occupies considerably less than one square mile, and probably the most important area is found near the center of the town of Freedom. Only a few other scattered areas occur in the county.

The surface is gently rolling, and the natural drainage is good. The soil is of glacial origin, and the native timber growth is practically the same as on the Superior soils.

This is an excellent agricultural soil, but because of its limited extent, but few if any farms are located entirely upon it.

In its crop producing power and general agricultural value, it compares very favorably with the best soils of the Superior series.*

MIAMI FINE SANDY LOAM.

Extent and distribution.—The largest area of this soil is found near the center of the county from three to seven miles

*For data on chemical composition and fertility, see page 36.

southwest of Black Creek in the towns of Black Creek, Bovina, and Ellington. The total area is approximately ten square miles. Aside from this rather extensive tract there are numerous other scattered areas of very limited extent.

Description.—The surface soil of this type to a depth of about ten inches consists of a brown to grayish-brown mellow fine sandy loam. The subsoil becomes somewhat lighter in color, and usually a little coarser in texture with depth. At twenty to twenty-four inches it is usually a yellowish fine sand or fine sandy loam which may contain considerable fine gravel and limestone particles.

The surface soil is inclined to be somewhat variable, but in most instances it can be classed as a fine sandy loam. In a number of places there is considerable gravel on the surface and where this is the case, symbols have been used to show this condition. Wherever boulders occur on the surface in sufficient numbers to interfere with farm operations, these have also been shown by symbols.

There is also some variation in the subsoil. A material of a loam of clay loam texture is sometimes found in the lower depths.

Topography and drainage.—The surface of this soil ranges from undulating to gently rolling, and in a few cases it is somewhat irregular or bumpy. In a few instances, the underlying rock occurs rather close to the surface, as for example, directly north of Stevensville where there is quite an elevation, the core of the hill being made up of limestone. Because of the uneven surface features and the rather open subsoil, the natural drainage of this soil is good.

Present agricultural development.—*Practically all of the timber has been removed, and most of the type is now in well improved farms. This is a soil which is easily cultivated, and one which has a fair to good agricultural value. All of the general farm crops common to this region are successfully grown upon it, and the yields secured compare favorably with those obtained upon the Superior fine sandy loam, rolling phase. The general farm processes followed, the rotations, methods of agriculture, fertilizers, etc., and the lines along which this soil could be best improved are practically the same as for the Superior fine sandy loam, rolling phase.

*For data on chemical composition and fertility of this soil, see page 36.

ANTIGO FINE SANDY LOAM.

Extent and distribution.—This type is closely associated with the Antigo loam, but is a little greater in extent. It is confined to the northwestern part of the county where it is found in the broad flat plains bordering the Embarrass, Wolf, and Shioce Rivers. A large area occurs in Deer Creek Township, northeast of Bear Creek, and another in Bovina Township north of Shiocton. The former is a little lighter in texture than the typical.

Because of its very limited extent, there has been included with the Antigo fine sandy loam a few small areas of Fox fine sandy loam. The most important tract is found in section 7 in the town of Dale. It differs from the Antigo type chiefly in being somewhat coarser in texture, and also in having a somewhat different origin, it having been derived from glaciated limestone material. It may have a slightly higher agricultural value than the Antigo since it is seldom acid, while most of the Antigo soils are acid.

Description.—The surface soil of the Antigo fine sandy loam to a depth of from six to eight inches is a brown to dark brown, loose, friable very fine sandy loam free from stones and gravel and carrying a fair amount of organic matter.

The subsoil grades very rapidly into a yellowish brown to pale yellow very fine sand of undetermined depth.

Topography and drainage.—The topography of the Antigo fine sandy loam is flat to very gently undulating. The surface is only a few feet above the usual high water mark of the neighboring streams; so after unusually heavy rains some of this type is subject to overflow. Owing to the loose character of the soil and the sandy subsoil, the drainage is fairly good. However, when the water in the streams is high, the water table of the soil is close to the surface.

Present agricultural development.—*It is a good agricultural soil. Over ninety per cent of this type is under cultivation. General farming and dairying are the prevailing forms of agriculture, although in the vicinity of Shiocton truck farming has come into prominence. Of the general farm crops, hay, oats, corn, barley, and rye are the most common. Hay does not yield quite as well as on the Antigo loam although yields of from 11½

*For data on chemical composition and fertility of this soil, see page 36.

to 3 tons per acre per year are not unusual where good practices are followed. Oats yield a little less than on the Antigo loam, average yields being from thirty to fifty bushels per acre. A rotation similar to that used on the Antigo loam is practiced by the farmers on the type. Potatoes are grown to some extent, and yield from 100 to 150 bushels per acre.

Of the special crops grown, cabbage, sugar beets, and onions are by far the most important. Of these cabbage ranks first. Where good farm practices are followed, average yields of from eight to twelve tons per acre are obtained. Sugar beets yield from six to twelve tons per acre, and onions from 150 to 350 bushels per acre.

The Antigo fine sandy loam is very easy to cultivate, and except under very unfavorable moisture conditions no difficulty is experienced in the preparation of a good seed bed.

ANTIGO LOAM.

Extent and distribution.—The Antigo loam is closely associated with the Antigo fine sandy loam, although it is of smaller extent. It is confined to the northwestern part of the county, where it is found in the broad flat plains bordering the Embarrass, Wolf, and Shioe Rivers. The largest areas occur in Deer Creek and Maple Creek Townships.

Description.—The surface soil of the Antigo loam for about eight to ten inches is a dark brown friable loam free from stones and gravel, and carrying a large percentage of very fine sand with considerable organic matter. The subsoil grades rapidly into a yellowish-brown very fine sand which becomes a pale yellow at about twenty-four inches. This continues to below four feet.

In places the soil becomes nearly a silt loam, and where this is the case, the sandy subsoil is not encountered until about twenty-four inches. A small area of the heavier phase is located just southwest of Helena, and another southeast of Bear Creek in Deer Creek Township.

Topography and drainage.—In topography the Antigo loam is flat, to very gently undulating. The surface is only a few feet above the usual high water mark of the neighboring streams; so after unusually heavy rains, portions of this type are inundated.

Owing to the sandy character of the subsoil the drainage is

usually fairly good, except when the rivers are high. At these times the water table is close to the surface.

Present agricultural development.—Practically all of this type is under cultivation. General farming and dairying are the prevailing forms of agriculture. The soil is well adapted to hay and oats, while all of the general farm crops common to the region do fairly well. It is not as well adapted to potatoes as is the Antigo fine sandy loam. Corn does not do well after wet spring as the ground remains cold until late in the season, and the high water table retards the development of the root system.

Of the special crops, cabbage and sugar beets are yielding the growers satisfactory returns. Cabbage yields from eight to fifteen tons and sugar beets six to twelve tons an acre.

Where good methods of farming are being followed the productivity of the soil is gradually being increased, but where careless methods are practiced, the yields are gradually declining. Spring wheat was formerly grown with good success, but the yields became poorer and poorer until the crop was finally abandoned over most of the area. Good farmers practice a rotation consisting of corn, followed by a small grain, such as oats, or barley, and then seeding with clover and timothy. Hay is cut for one or two years, and is usually pastured a year, after which it is manured and then plowed for corn.

The Antigo loam is comparatively easy to cultivate and when worked under favorable moisture conditions, no difficulty is experienced in securing a good seed bed. It is usually best to fall plow, for if the spring is wet, some difficulty may be experienced in getting the crop sown on time.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS.

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the fine sandy loams as in the silt loams. However, they have rather less organic matter, and this, together with the somewhat coarser texture, results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of producing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

The degree of acidity in the Antigo soils is seldom more than "slight" in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of all crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop, and also to watch the growth of clover carefully from year to year, so as to begin the

use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

The Superior and Miami soils of this group have been derived from materials which contain varying amounts of lime carbonate. The subsoils are usually well supplied with lime, but the surface soils frequently show varying degrees of acidity, due partly to the long period of leaching to which they have been subjected. The degree of acidity is seldom as great as on the Antigo soils, however.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage. These soils which are of intermediate texture are better adapted to potato culture than are the heavier types on the one hand or the light sandy soils on the other. It is necessary to give these soils somewhat more attention to maintain their fertility than the heavier types partly because they are lower in fertility, but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for special crops the fertility can best be maintained by rather heavy applications of stable manure, or through the use of a rotation in which a legume is grown as the means of securing the organic matter and nitrogen, while the other elements chiefly phosphorus and potassium, are supplied in the form of commercial fertilizers. When the latter system is used one-third or one-fourth of the land should be sown to a legume and a part of the commercial fertilizer used on this crop. The fertility used in this way would become available to succeeding crops through the decomposition of the legume when plowed under. The remainder of the fertilizer would be applied at the time of fitting the soil for the succeeding crops.

CHAPTER IV.

GROUP OF FINE SANDY SOILS.

COLOMA FINE SAND.

Extent and distribution.—This type is comparatively small in extent, and of minor importance from an agricultural standpoint. It is mainly confined to the northwestern part of the county, the chief areas occurring in the vicinity of Hortonville and Stephenville. Other small isolated areas are found scattered throughout the county, usually occurring as small hilltops or ridges.

Description.—The surface soil of the Coloma fine sand to a depth of from eight to twelve inches is a grayish brown loose, open fine sand, containing but little organic matter. The subsoil is a loose fine sand continuing to over three feet, and grading from a light brown to a yellowish brown or pale yellow in the lower depths. Gravel beds covered by a thin mantle of surface soil are often found throughout the type.

The organic matter content varies over different sections of the type, being higher in the depressions where the moisture conditions have favored an accumulation of humus-forming material. Dunes formed by wind blown sand are occasionally found.

There are several variations which have been included with this soil, but which, had they been of any important extent, would have been mapped as separate types. In the northwestern part of the county, chiefly in the town of Maine, there are numerous small tracts of light-colored soil which has a very fine sandy texture. It is loose and open in structure, and usually entirely free from stones and gravel. The subsoil is a yellowish brown or yellow very fine sand which extends to an undetermined depth. This material differs from the typical Coloma fine sand only in being finer in texture. Because of this finer texture, it probably has a somewhat higher agricultural value, although this is not apparent from the crop yields which are now being secured.

Another variation occurs in the town of Liberty in sections 13 and 14, and also in a number of other localities, but always in small patches. This soil is the same as the Coloma fine sand to a depth of 24 to 36 inches where it is underlain by the red clay typical of the Superior series. Because of this underlying clay, this phase is a better soil than the typical, and would have been mapped as the Superior fine sand or fine sandy loam, rolling phase, had it been of sufficient extent.

Topography and drainage.—The topography of this type ranges from undulating to hilly. On account of its loose, open structure, the natural drainage is somewhat excessive, and the type is very liable to suffer from drought except during seasons of excessive rainfall.

Present agricultural development.—*Over seventy-five per cent of the Coloma fine sand is under cultivation to the general farm crops common to this region. Corn gives an average yield of about twenty bushels, oats fifteen to twenty bushels, rye twelve bushels, timothy and clover three-fourths to one ton, and potatoes from fifty to one hundred bushels an acre. By careful cultivation, rotation, and fertilization, these yields have been more than doubled by some farmers.

Over most of this type but little attention is given to the selection of a rotation particularly adapted to this soil. The methods of cultivation are similar to those followed on other sandy types of the county. The soil is loose and open, and is very easily cultivated.

It may be said of this type as a whole that the methods now followed upon it are not such as tend to increase its productivity, although there are exceptions where more up-to-date methods are being practiced.

COLOMA FINE SANDY LOAM.

The surface soil of this type to an average depth of eight to ten inches consists of a light brown to grayish brown fine sandy loam, which rests upon a subsoil of about the same texture, but having a somewhat lighter color. In the lower depths, the material is usually a fine yellow sand, with which varying amounts of fine gravel may be found. The material is quite uniform in texture, and is stone free.

*For chemical composition and fertility of this soil see page 42.

The type is of limited extent and of minor importance. It occurs in small scattered tracts, the most important of which are found in Grand Chute and Maine Townships.

The surface is undulating to gently rolling and because of the sandy nature of the material the natural drainage is good and frequently excessive.

The original timber growth was mixed pine and hardwood, with hardwoods predominating. Practically all of the original timber has been removed.

This is a soil of only medium to fair agricultural value. It is deficient in organic matter and mineral plant foods, but its texture is such that by growing green manuring crops, following good crop rotations, and using proper fertilizers it can be built up into a profitably producing soil. Small grain, clover, and potatoes are a good rotation for this kind of land, with the second crop of clover plowed down. Liming will help in getting clover started and commercial fertilizers can also be used with profit. A 2-10-4 will give good results. From 150 to 200 pounds per acre should be applied to corn or small grain crops. Potatoes should have larger applications.

This soil has been included with the group of fine sands because in its agricultural value it more nearly approaches these soils than the group of loams and fine sandy loams, which usually have heavy subsoils.

PLAINFIELD FINE SAND.

The surface soil of this type to an average depth of eight inches consists of a loose, grayish-brown, very fine sand which contains but little organic matter. It is entirely free from gravel and stones. Below eight inches the material becomes lighter in color, usually being a pale yellow or yellowish-brown. The texture continues a very fine sand to undetermined depth.

This soil is of very limited extent, but is found in a number of small tracts in several regions, chiefly in Maine, Deer Creek, and Bovina Townships.

The surface is level or only gently undulating with some minor irregularities caused by wind action. In many places the water table is not far below the surface, so that during part of the year the drainage is none too good. When the streams are low, the loose, open character of the material permits the free movement of water through the soil, and the type often suffers from lack of moisture during the dry portion of the summer.

This soil is of minor importance because of its limited extent and also because of its rather low value from the standpoint of crop production. While part of it is under cultivation, the yields are low. It is low in organic matter, and the mineral plant food elements.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds. The total potassium of the surface eight inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Superior silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface eight inches and from one to two per cent in the second eight inches. They have a correspondingly low nitrogen content averaging from 1,000 to 1,500 pounds in the surface eight inches. This organic matter is largely in the form of leaf-mold and fine roots, and it decomposes quickly when the surface is first broken, furnishing a limited supply of nitrogen for a growth of crops. However, it is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases, and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover, but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown, and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is prac-

ticed it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover, occasionally, all of which is to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil productivity. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover, and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown, and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils, it must not be considered that this is an indication that they have less value than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204, 230 and 341 of the Experiment Station.

CHAPTER V.

GROUP OF POORLY DRAINED SOILS.

POYGAN CLAY LOAM.

This type is of very small extent. Small areas are found near the center and southeastern parts of the county, the largest of these occurring north of Stevensville in Ellington Township. It is closely associated with the Superior clay loam and silt loam, and occupies depressions and low, gently sloping areas bordering streams.

The surface soil of the Poygan clay loam to a depth of from eight to fifteen inches is a dark brown to black, sticky compact clay loam, rich in organic matter. The subsoil becomes lighter in color for a few inches before grading into pinkish-red clay at from fifteen to twenty inches. This clay is very compact and tenacious and extends to an undetermined depth.

In topography the Poygan clay loam is flat to gently sloping. The surface is low which coupled with the impervious character of the subsoil makes the natural drainage very poor.

Less than half of this type is under cultivation. The greater part of it is badly in need of drainage, and in its present condition is valuable only as pasture and for the marsh hay which may be cut. Where the type has been properly drained, it has a high agricultural value. It is especially adapted to hay and small grains, while corn and other crops common to the region do well. It is rather heavy for potatoes, but cabbage and sugar beets are grown with fair success.

POYGAN SILT LOAM.

No areas of Poygan silt loam of any great extent are found, although small patches of the type occur scattered throughout practically every township in the county. It is closely associ-

ated with the soils of the Superior series, and occupies depressions and flat areas bordering streams and marshes.

The surface soil of the Poygan silt loam to a depth of from eight to ten inches is a dark brown to black sticky, compact silt loam, rich in organic matter. The subsoil becomes lighter in color for a few inches before grading into the heavy tenacious red clay subsoil at from twelve to fifteen inches.

In places the red color of the subsoil may entirely disappear, but the texture and other characteristics remain the same. The blue clay subsoil areas are too small to be mapped out separately.

In topography the type is flat to gently sloping. The surface is low, and the subsoil is quite impervious to water which makes the natural drainage very poor.

The original forest growth consisted principally of black ash, elm, maple, with some oak, hickory, poplar, birch, alders, etc. In most places the valuable timber has been removed.

Very little of this type is under cultivation. The greater part of it is badly in need of drainage; so in its present condition, it is valuable chiefly as pasture land. Where the type has been properly drained, it has a high agricultural value. It is not well adapted to potatoes, but other crops common to the region and small grains, grasses, cabbage, sugar beets, etc., do well.*

POYGAN FINE SANDY LOAM.

This type is of very small extent. It is usually associated with the Poygan silt loam, or the Superior fine sandy loam. Small isolated areas are found scattered throughout the county where it occupies depressions and gentle slopes bordering streams or marshes.

The surface soil of the Poygan fine sandy loam to a depth of about seven inches is a dark brown to black, friable mellow, fine sandy loam, carrying a relatively high per cent of organic matter. The subsoil for three or four inches usually is a fine sand, to very light fine sandy loam, which then grades into a pinkish-red clay loam to clay.

The topography of the type is flat to gently sloping. The surface is low and the natural drainage is poor.

*For data on chemical composition and improvement of this soil, see page 46.

The timber growth consisted of ash, elm, maple, with some oak, hickory, birch, willow, poplar, alders, etc. The best timber has been removed. But very little of this type is under cultivation. When well drained, it yields fair results when the crops common to the region are grown. It is an easier soil to handle than the Poygan silt loam and clay loam, but the yields, especially of grains and hay, are not as large.

CHEMICAL COMPOSITION AND FERTILITY OF POYGAN CLAY LOAM, SILT LOAM, AND FINE SANDY LOAM.

These soils have relatively large amounts of organic matter accumulated as a result of poor drainage. The supply of phosphorus is usually fairly high, but in some cases it is not readily available. Its availability will depend largely upon the rate of decomposition of the organic matter. The total amount of potassium is fair in the fine sandy loam, and large in the silt loam and clay loam, but the chief question here also is regarding its availability.

While soils well supplied with vegetable matter as these are do not need special treatment with reference to potassium and phosphorus immediately after reclamation, they very generally do show a need of care in this regard within a few years, and patches of these types frequently fail to produce satisfactory crops even immediately after drainage and breaking unless stable manure or special mineral fertilizers are used.

In the improvement of these types the first step is, of course, drainage. Both open ditches and tile drains can be installed to advantage. Plowing fields in narrow lands with dead furrows two to four rods apart, and having these lead into shallow open ditches along the side of the field, will greatly assist in carrying off surface water. In order to make the internal drainage of the soil complete, however, tile drains should be used to supplement the surface ditches.

With thorough drainage these soils will be adapted to a wide range of general crops. Special crops such as cabbage and sugar beets are well suited to these lands when drained.

WHITMAN LOAM.

Extent and distribution.—This type is of small extent, occupying less than ten square miles in the county. The two largest

areas occur in Bovina township, one west and the other northeast of Shiocton. Other small, isolated areas are found scattered about in the northwestern part of the county.

Description.—The surface soil of the Whitman loam to a depth of about seven inches is a dark brown to black, mellow, friable loam rich in organic matter. It carries considerable silt, and sometimes considerable very fine sand. It is free from stones and gravel. The subsoil rapidly becomes lighter in color and coarser in texture, until at about fifteen inches it is a yellowish brown to pale yellow very fine sand. This continues to well over three feet.

In places the subsoil will carry a little sandy clay which is a mottled drab, yellow and brown color, but such areas are very small.

Topography and drainage.—The topography is level, which with the low position of the type, makes the natural drainage poor. The water table is usually within a few feet of the surface and during the spring the soil is almost completely saturated. At times, portions of the type are several inches under water. In places open ditches have been constructed.

Present agricultural development.—Where properly drained, the general farm crops common to the region are grown and excellent yields obtained. About half of the type is under cultivation. Of the special crops, cabbage, beets, and onions do well, and some celery has been successfully grown. The chief requirement of the land is good drainage. The undeveloped portion of the type is valuable only for the pasture it affords, and the marsh hay which may be cut.

Chemical composition and fertility.—The Whitman loam is quite similar to the Clyde loam of southeastern Wisconsin, differing chiefly by being acid, while the Clyde soils are not acid. It also carries a larger proportion of very fine sand than does the Clyde loam. From the standpoint of the plant food elements which it contains, this may be considered a well-balanced soil.

The Whitman loam contains from three to five times as much nitrogen and organic matter as does the average light-colored upland soil of this region. It contains from 1,500 to 2,000 pounds of phosphorus in the surface eight inches an acre, and from 40,000 to 45,000 pounds of potassium.

In the improvement of this type the first step is to supply adequate drainage. Open ditches will not be sufficient by themselves, and should be supplemented by the use of tile drains. When well drained, this will become one of the strongest and most productive soils in Outagamie County. Because of the low position of some of this type, its improvement would at present require diking, which, under present conditions, would not be justified.

DUNNING FINE SANDY LOAM.

The surface soil of the Dunning fine sandy loam to a depth of from four to seven inches is a dark brown to black, loose, friable, very fine sandy loam, free from stones and gravel, and carrying a high percentage of organic matter. The subsoil grades abruptly into a pale yellow very fine sand, which continues to well over three feet.

This type is of small extent and of minor importance. It occurs only in small isolated areas scattered throughout the northwestern part of the county. The main areas occur in the eastern half of Maine Township.

The topography is level, which with the low position of the type makes the natural drainage poor. The water table lies close to the surface, and for portions of the year parts of the type may be covered with a few inches of water.

The timber growth consists mainly of alders, quaking aspen, birch, and some maple, elm, and black ash. Practically all of the good timber has been removed, but a dense second growth covers most of the area. Very little of this type is under cultivation. The principal crops are oats, timothy hay, and marsh grass. On small areas which have been properly drained, cabbage and onions are being grown successfully.

Chemical composition and fertility.—The Dunning fine sandy loam is well supplied with nitrogen and organic matter in the surface soil, but it is usually deficient in the mineral plant foods, phosphorus and potassium. The greatest deficiency is drainage, however, and before cultivated crops can be grown successfully, a thorough system of drains must be provided. Open ditches as now installed in some places are not sufficient in themselves, and must be supplemented either by open laterals or tile drains. When drainage has been provided, it will be found that the

most economical and profitable crop production can be secured by the use of mineral fertilizers containing phosphorus and potash. Such crops as alsike clover and timothy, buckwheat, and corn may be expected to give good results on this kind of land under good management. Corn may not always mature because of the danger from frosts on the low land, but one is reasonably certain of always securing good silage.

CLYDE SILT LOAM.

The surface soil of this type to a depth of about eight inches consists of a black friable silt loam which contains a very large amount of organic matter. The subsoil begins as a dark-colored silt loam to about twelve or fourteen inches, when it becomes somewhat lighter in color, frequently being of a grayish or blue tinge and also being lighter in texture. The subsoil is quite variable, but is most often sandy loam below eighteen inches. In a few instances it was found to be a very fine sand which was mottled in color.

There are some variations, but the most important one is where the surface is really a clay loam, and the subsoil a heavy bluish silty clay loam with lenses of sand in the lower subsoil. This phase could justly be classed as Clyde clay loam, except that its very limited extent makes it of little importance. This type is of limited extent and of minor importance. It is confined to the eastern and southern parts of the county, and occurs in a number of widely separated areas. One of these, and perhaps the largest, occurs in Section 15 in the town of Osborn. Other areas are found in Sections 22, 23, and 24, in the town of Ellington, and in Section 6 in the town of Center. Several other small tracts occur in the town of Dale. The surface of this soil is level or having only a very gentle slope. Because of its low position and level surface, the natural drainage is very poor, and before it can be used for cultivated crops drainage is necessary.

But very little of this land has been cleared and placed under cultivation, owing to the fact that its drainage is very deficient. The best timber has been removed, and some of this land is now being used as pasture land. Where it is possible to drain this soil, it can be made very excellent land.

In the improvement of this soil, drainage is the first consideration. From the standpoint of the amount of plant food which

it contains, it is a well-balanced soil, and when drained will be adapted to a wide range of crop production. Sugar beets and cabbage are special crops which do well on this soil.

CLYDE FINE SANDY LOAM.

The surface of this soil consists of a dark brown or nearly black fine sandy loam to a depth of about eight inches. The subsoil is a fine sand, or fine sandy loam, extending to a depth of over two feet. In color the subsoil is a little lighter than the surface and may consist of a gray or yellowish, or sometimes mottle material.

This type is of limited extent, occupying less than two square miles. It is found in small scattered areas chiefly in the towns of Bovina, Osborn, and Ellington. The surface is low and level, and the natural drainage is very poor. This soil has the same origin as the Clyde silt loam, and supported practically the same original timber growth.

There is but very little of this soil improved at present because of its poor drainage, and before it can be used for cultivated crops drainage is necessary.

GENESEE SILT LOAM.

The surface soil of the Genesee silt loam consists of about eight inches of brown, friable, silt loam, which at times carries a considerable quantity of very fine sand, and is usually comparatively high in organic matter.

The subsoil is a light brown loam to silt loam, which usually becomes lighter in color with increase in depth until at twenty-four inches it is a pale yellow to yellowish brown.

The type is subject to considerable variation in texture and depth. The subsoil is sometimes sticky, although it often carries large quantities of fine sand, and may grade entirely into fine sand at from two to three feet. Small areas of shallow peat and fine sand are encountered, although none of these variations are large enough to be indicated on the soil map.

This type is confined chiefly to the valleys of the Embarrass, Wolf, and Shioc Rivers, although it is found to some extent along practically all of the streams in the northern and western parts of the county.

The topography is level except where old stream channels cut across the type in numerous places. The surface is low, subject to annual overflow, and is usually wet during the spring and early summer months. During dry spells when the streams are low, the soil is fairly well drained.

The material forming this soil is of alluvial origin, derived from sandstone and granitic rock debris.

The forest growth consisted chiefly of swamp oak, elm, basswood, maple, and ash with some willow. The best of the timber has been removed, although there is still a good stand of trees over most of the area, and in places a dense undergrowth including alders is encountered.

All of this type is subject to overflow. For this reason, little attempt at improvement has been made. Aside from the marsh hay which can be cut from a portion of the type and the pasture which it affords, it has but little present agricultural value.

If protected from overflow, this type would have a high agricultural value. A proposed canal, designed to carry the excess water from the Wolf River, across the northern part of the county into Duck Creek, if brought into successful operation would solve to a large degree, the difficulty which has been encountered in the improvement of this type.

GENESEE FINE SANDY LOAM.

The surface soil of the Genesee fine sandy loam consists of about eight inches of brown, friable, very fine sandy loam. The subsoil is a little darker in color, but the texture usually remains the same to below three feet. In places very fine sand is encountered at from eighteen to twenty-four inches.

Small areas of fine sand and shallow peat are encountered, although none of these variations are large enough to be indicated on the soil map.

This type is confined chiefly to the valley of the Wolf River, where it occupies low flats bordering the stream. The surface is low, subject to annual overflow, and is usually wet during the spring and early summer months. During dry spells when the stream is low, the soil is well drained.

The best of the timber has been removed, but there still remains a good stand of trees, and in many places dense undergrowths are encountered. As all of this type is subject to over-

flow, little attempt at improvement has been made. Aside from the marsh hay which may be cut from a portion of the type, and the pasture which it affords, it has a very low agricultural value. In all respects it is very similar to the Genesee silt loam, except that the latter is higher in organic matter, and has a finer texture.

The drainage of this type under present conditions would be very difficult in most cases, and it is probable that it will not be improved for a long time, except for a few patches of the type which are more favorably located than the average. With good drainage, it will make a productive soil, adapted to a wide range in crop production.

PEAT.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw fibrous condition, showing quite plainly the structure of the vegetable growth from which it is derived. In a fibrous condition the material is brown, but with decomposition its color becomes darker, and where thoroughly decayed it is black or very dark brown. Mineral matter may be incorporated with the organic matter, but seldom in sufficient quantities to appreciably offset the texture. In the more extensive areas of Peat there is little or no mineral matter except about the margins, where the proportion is frequently sufficient to form muck. The mucky areas are too small to be satisfactorily separated, however, and are included with the Peat.

The depth of Peat is variable. The areas in which it is less than eighteen inches are separated as a shallow phase. In some places the organic deposits are more than ten feet deep and in practically all the swamps with an area of one square mile or more, the depth is more than three feet. It is generally deepest in the center of the areas, and shallowest about the margins.

In large swamps and marshes where the material is still raw, there is very little difference in character between the surface material and the material several feet below the surface. Where conditions have favored rapid decomposition the material at the surface is frequently darker than that at lower depths, but where the accumulation of vegetable matter on the surface has been rapid, the lower depths are more decomposed and darker in color. A profile section may consist of eight to sixteen inches

of slightly decomposed to well decomposed brown to dark brown vegetable matter, underlain by similar material which may be more decomposed, or may be in a very raw condition.

The material underlying the peaty matter is variable, and ranges from sand to silt loam or clay loam. In general, its texture is determined largely by that of the surrounding upland soil. In the regions of silt loam soils the underlying material is usually heavy and of a grayish to dark brown color. Throughout the sandy sections in most cases the peaty material is underlain by grayish to nearly white sand to very fine sand.

In places small islands of Muck, sand, or other soils have been included with the Peat. Such areas were too small and unimportant to be separated.

Areas of Peat are distributed through all parts of the county, but are most extensive in the northwestern part. The largest areas occur in the townships of Black Creek, Bovina, Liberty, and Hortonia.

Practically all the Peat areas are level, or have only a very gentle slope. The slope is nowhere sufficient to drain the material without the use of open ditches. Most of the areas of Peat are wet the greater part of the year, and there are often a few inches of water over the surface in the spring when heavy rains occur.

Most of the marshes in which Peat occurs have sufficient slope to be successfully drained. In a few instances drainage districts have been organized, and rather extensive drainage projects are being developed. However, at present very little of the Peat is under cultivation, and its agricultural value in its present state is low.

The native trees of the Peat consisted chiefly of tamarack and cedar. Some of the marshes do not support any trees or have only scattered growths of tamarack, cedar, ash, etc. In most of these places the original timber has been destroyed by fire, though a few marshes apparently have always been treeless. On some of the open marshes there is a coarse grass which is cut for hay, but in most cases the vegetation consists of moss, blueberry bushes, and other moisture-loving plants.

PEAT, SHALLOW PHASE.

Peat, shallow phase, is differentiated from the typical peat, solely on the basis of the thickness of the peaty deposit, the maximum in the phase being eighteen inches. The underlying material is very variable, and usually corresponds quite closely to the surrounding uplands. In regions where the surrounding soils are heavy, the subsoil is usually a silt loam or clay loam, often mottled in color. Where the uplands are sandy, the material composing the subsoil is usually light, consisting of fine sandy loam to very fine sand. The depth of the peaty material is also variable, and ranges from six to eighteen inches.

In places small islands of muck, sand, or other soils have been included with the peat. These areas were too small and unimportant to be mapped separately.

The shallow phase of Peat is not very extensive and occurs only in small areas scattered throughout the county.

The timber growth of this phase is practically the same as for the typical Peat, with the exception of tamarack. This tree is found only in a few places on shallow Peat.

The production of marsh hay is about the only use made of this soil at present. It is used to a small extent for grazing. In its present condition it has a low agricultural value. When drained it will be adapted to the same crops and types of farming as the typical Peat.

In most cases it is easier to improve the shallow phase as it will be more easily drained, and will require less compacting to make a good seed bed.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT SOILS.

In the improvement of the peat lands of Outagamie County, the first step is drainage. With the exception of some of the marsh land immediately adjoining some of the larger streams, it is thought that most of the marshes could be readily drained and successfully cultivated. Along some of the larger streams, the surface of the Peat is so low that much of it would require diking, or the lowering of the bed of the stream, which would be very expensive and hardly justifiable under present conditions.

The crops adapted to this land depend to a considerable extent on the degree of drainage secured, and on the thorough-

ness with which the ground is prepared. A much less expensive and complete drainage system would be necessary to fit this land for tame hay such as timothy and alsike clover than would be needed to fit it for corn, sugar beets and other cultivated crops. For its highest development agriculturally, a tile drainage system in which the laterals are not more than eight to ten rods apart would be essential.

The chief difference between peat soils and upland soils consisting largely of earthly matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average percentage of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds, in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average of 0.3 per cent of this element, while good upland clay loam soils average 2 per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potash. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well

as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potash used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye and, to a less extent, oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.

CHAPTER VI.

GENERAL AGRICULTURE AND CLIMATE.

HISTORY.

As was the case in a large number of Wisconsin counties, the development of Agriculture in Outagamie County was preceded by the logging and lumbering industries.

The first settlement in what is now Outagamie County was made about 1843 by Father Van Der Broeck who had been missionary to the Indians of the region for a number of years. He was instrumental in bringing a colony of Dutch immigrants who located at Little Chute. During this same year, the first buildings were erected in Appleton. The first farms opened after the advance of the lumbermen were small tracts, and often large areas of land remained in the cut-over stage for a considerable time before being parceled out in small farms.

As the timber was first removed from the region adjoining the Fox River, agricultural development had its beginning also in this region.

The crops which were grown by the early settlers were chiefly those which were used for home, or, at least, local consumption, and consisted largely of wheat, corn, potatoes, hay, root crops, etc. The methods which were at first followed were crude and no attempts were made to follow any definite system of rotation or cultivation. Throughout the Fox River Valley the soils are of a heavy nature, and cultivation is more difficult than on the lighter soils. Cultural operations were not thorough. At times the ground was scratched only a little before grain was planted.

While nearly all of the merchantable timber has been removed from this county and a large proportion of the land placed under cultivation, there are still some sections which have considerable undeveloped land. The section least developed is confined to the northeastern part of the county which

was originally included in the Oneida Indian Reservation. In the northwestern portion of the county in Maine, Deer Creek, Bovina, and Maple Creek townships there are considerable areas which are also unimproved due to the fact that in this region there is a large amount of poorly drained land and also some that is of a sandy nature. The greater proportion of the county, however, is highly improved agriculturally.

While practically all of the general farm crops now grown were produced in the early history of the region, the relative importance of a number of crops has changed to a considerable degree. From the various census reports we gather very interesting information along this line. In 1880 there were 40,906 acres devoted to wheat which was nearly three times the acreage devoted to oats, and more than twice the acreage devoted to corn. In 1890 there were only 22,000 acres in wheat, but the acreage of oats had increased to over 31,000. In 1910 the acreage of wheat had dropped to 549 while the acreage of corn was 28,000 and oats 53,000. In 1920 there were 6,748 acres in wheat. In 1880 there were only about 3,000 acres in barley; in 1910 there were over 17,000 acres, and in 1920, 9,600 acres. The following table shows the relative importance of the leading crops over a period of years.

TABLE SHOWING ACREAGE OF LEADING CROPS OVER A PERIOD OF YEARS.

Crop	1880	1890	1900	1910	1920
Wheat.....	40,906	22,000	15,113	549	7,301
Corn.....	17,559	11,908	20,344	28,088	21,177
Oats.....	15,209	31,478	54,680	53,004	46,116
Barley.....	2,964	3,097	10,229	17,403	9,600
Rye.....	1,269	4,191	2,961	2,744	2,923
Hay.....				48,502	59,181

PRESENT STATUS OF AGRICULTURE.

The Agriculture of Outagamie County at present consists chiefly of general or mixed farming with dairying as the most important branch. The chief crops grown according to acreage (taken from the 1920 census) are hay, oats, corn, barley, wheat, potatoes, and rye, with buckwheat, peas, sugar beats, and beans as crops of less importance. During the past few years the acreage of wheat has increased over ten fold. This increase was undoubtedly due to the greater demand for wheat owing to the war situation.

Practically all of the crops grown in this region may be considered in part as cash crops, for hay, corn, oats, rye, and barley are sold to some extent directly from the farms. Potatoes are grown mainly for sale although they are one of the most important subsistence crops. By far the greater proportion of the hay, corn, and oats produced is used in feeding livestock, and thus much of it finally reaches the market in the form of dairy products, beef, and pork. A considerable quantity of grain and hay is used as feed for work stock.

Oats is grown more extensively than any other crop except hay. Its production is distributed throughout the county, and while it is grown on nearly all of the soils, best returns are secured from the fine sandy loams, loams, and clay loams rather than from the soils of lighter texture.

Hay is the crop which is first in importance from the standpoint of acreage. This includes timothy and clover, together or separately, alfalfa, and also such crops as oats, or oats and peas which may be cut green for hay. Only a small proportion of the total hay crop consists of this latter variety, however. Hay makes its best growth on the soils of medium to heavy texture rather than on the light sandy types.

Corn is the crop of third importance from the standpoint of acreage. While corn will usually mature in this section a large proportion of it is used as ensilage since nearly every farmer has a silo. The soils of this county which are best adapted to corn raising are the fine sandy loams which have a rather heavy subsoil, since the sandy surface permits the ground to warm up quite early; so the crop can get a start more readily than on the heavier soils where the drainage is rather deficient, and the ground rather cold in the spring.

Barley is a crop of considerable importance and is grown on a variety of soils.

Rye is confined more extensively to the sandy portions of the county because these soils will produce rye better than any other grain crop.

The growing of potatoes while of some importance has not reached the magnitude which this industry has in either Waupaca or Portage Counties to the west. This fact is due chiefly to the soil in Outagamie County some of which is heavy and not so well suited to the commercial growing of potatoes as are the lighter soils of the other two counties mentioned. In 1920 the

total area was 4,138 acres. Commercially potatoes are confined more extensively to the sandy soils of the northwestern portion of the county. They are also grown to a considerable extent on such soils as the Superior fine sandy loam, rolling phase, which is very well suited to this crop.

There are a number of special crops which are grown to some extent in this county. The most important of these crops is cabbage, grown most extensively in the vicinity of Shiocton. In this region cabbage is grown chiefly on the alluvial soils. The total acreage amounted to 2,550 acres, according to the county report of 1917, with an average yield of 9.8 tons per acre, or a total production of nearly 25,000 tons.

Onions and sugar beets are also grown to a limited extent.

Some trucking is carried on in the vicinity of nearly all the towns, especially in the vicinity of Appleton and Kaukauna, although the soils in that portion of the county are not particularly well suited to this industry. These truck crops consist of cabbage, lettuce, radishes, onions, strawberries, and other vegetables and small fruits.

The following table shows the acreage and production of the important farm crops in Outagamie County.

TABLE SHOWING ACREAGE OF FARM CROPS IN OUTAGAMIE COUNTY, WISCONSIN.

Crop	1909	1919
Corn-----	28,038 A.	37,840 A.
Oats-----	53,004	46,116
Winter wheat-----	246	
Spring wheat-----	287	
Wheat-----		7,301
Barley-----	17,403	9,600
Rye-----	2,744	2,923
Buckwheat-----	334	399
Dried peas-----	649	277
Tame hay-----	48,502	49,181
Clover and timothy-----		47,713
Alfalfa-----		321
Cabbage-----		24,990 T.
Beans-----	138	
Wild hay-----	3,422	
Potatoes-----	4,276	4,138 A.
Sugar beets-----	403 A.	508
Silos-----		1,698

The growing of fruit is given comparatively little attention in Outagamie County. The fruit which is produced is grown chiefly for home use. On many of the farms there is a small orchard, which usually supplies apples for home use. Apples

do best over that portion of the county where the surface is somewhat rolling, on such as the rolling phase of Superior fine sandy loam and Miami types. The census of 1920 reported that there were at that time about 51,538 apple trees in the county of bearing age. There were also 7,390 cherry trees of bearing age.

There were approximately 600 grape vines in bearing at that time, and about 72 acres devoted to strawberries.

In this connection the fact may also be mentioned that in 1920 there were about 3,865 maple trees which were being used for the production of maple syrup and sugar.

The raising of live stock is an important industry in this region. Dairying is the most important branch of the live stock industry, but some beef cattle and a large number of hogs are also raised.

Poultry may be mentioned along with the general live stock industry.

Dairying is by far the most important branch of agriculture which is followed in Outagamie County at present. The census of 1919 reported that there were slightly over 56,000 dairy cows in the county. During that year approximately 17,550,000 gallons of milk were produced. The dairy products find their way to market chiefly in the form of cheese, butter, and condensed milk. There is also an appreciable amount of milk which is delivered as whole milk in the towns and cities of the area, and also some whole milk which is shipped to Green Bay.

There is one condensery in New London, just over the line in Waupaca County, which receives a considerable amount of milk from Outagamie County. In 1917, there were twenty-one butter factories and eighty-six cheese factories in the county. Of the dairy cows, those of the Holstein breed are most numerous, and there are a number of pure breds throughout the county although the grades still predominate. The following table shows the number of butter and cheese factories in this county, and also the amounts of cheese which have been produced and marketed.

TABLE FROM WISCONSIN DAIRY AND FOOD COMMISSIONER.

	Butter Factories	Cheese Factories
1910.....	20	79
1913.....	19	79
1916.....	24	81
1918.....	21	86
	Pounds of cheese produced	Amount received for cheese
1915.....	9,190,978	\$1,246,872.25
1917.....	9,535,888	2,061,424.32

ADAPTATION OF CROPS TO SOILS.

There is wide variation in the texture of the soils as they are found in Outagamie County, and also a wide range in the drainage conditions. It is generally recognized by farmers that some crops are better adapted than others to various soil types, but not so much attention has been given to the selection of crops and their adaptation to soils in this region as should be. As a result of experiments conducted at the various experiment stations, valuable information has been secured in this connection. In selecting crops to be grown, the question of climate should be considered as well as soil, since in this region the growing season is somewhat shorter than in southern Wisconsin, and with such a crop as corn which is susceptible to frosts, this is a very important matter.

In the growing of corn, the texture of the soil in this region is very important. On the heavy soils, the season is often rather backward; and since the season is rather short, the soils of a somewhat sandy nature are preferred. Probably the Superior fine sandy loam, rolling phase, is one of the best corn soils of this region. At the Spooner Station, the variety of corn known as Wisconsin No. 25 has been found to ripen within one hundred days. This variety is often ripe enough to permit seed selection by August 23d, may be fully ripe August 30th, and yet produced eight to fifteen tons of silage per acre. For seven years No. 25 averaged 57.4 bushels of corn an acre.

In the matter of raising oats, this crop is better adapted to the soils of heavy texture, fine sandy loam or heavier, rather

than to the lighter soils. On the Ashland Experiment Farm, Pedigree No. 4 (Early Gothland) has been found to be a very satisfactory variety of oats to grow. In 1920 this variety outyielded all other varieties, and in spite of a favorable season to favor rank growth, showed very little lodging. So far, early Gothland seems especially well adapted to upper Wisconsin, although one other new strain, No. 1214, has outyielded Pedigree No. 4 by eight bushels an acre on a six-year average. The Ashland Station is on heavy, red clay soil, which is practically the same as the soil in the Fox River Valley.

Wheat is grown to some extent in this region, and could be grown much more extensively with profit. At the Ashland Experiment Station on the red clay land the variety of wheat known as Baska, No. 408, has yielded as high as 51 bushels an acre, or an average of 31 bushels for a seven-year period. The variety No. 11837 yielded 34.2 bushels an acre for seven-year period, and variety No. 11825 yielded 32.4 bushels an acre for the same period. These are all winter wheats, and it has been demonstrated that winter wheats give larger yields and are more profitable to raise than spring wheats. Of the spring grain which have been tried, Marquis seems to give the best results. The well drained red clay lands seem to be better adapted to wheat growing in northern Wisconsin than the other type of soils. In considering these results it should be kept in mind of course that the climatic conditions at Ashland are somewhat different than in Outagamie county, although similar soils are to be found in both regions.

Peas are grown to a greater or less extent in this region, and their production could be materially extended with profit. The varieties which have given the best results at the Ashland Experiment Station on the red clay are the Scotch, which has yielded 22.9 bushels an acre over a period of ten years, and the Green which yielded 22.6 bushels an acre over the same period. Peas pay better and give a larger profit per acre than any of the small grains.

The growing of rye can be made profitable, and this crop is especially well adapted to soils of a somewhat sandy nature; in fact, it does better on the sandy soils than any of the other small grains. Wisconsin Rye, Pedigree No. 2, has given very good satisfaction as grown at the Spooner Experiment Station, as well as in other sections of the state. Winter rye should be

grown instead of spring rye, since the yields are materially higher, the average for several years at the Madison Station giving 44.1 bushels (winter rye), and 23.9 bushels spring rye. The weight per bushel of the winter rye is also somewhat higher than the spring rye. Rye can be grown with profit on heavy soils as well as light soils, but as indicated, it gives better results on the sandy land than the other small grains.

Potatoes where grown on a commercial scale usually give more satisfactory results on soils which are somewhat sandy. Potato growing in Outagamie County is not so highly developed as in Portage or Waushara County, but there are soils here which are very well adapted to this crop. The Superior fine sandy loam, rolling phase, should be especially well suited to potato growing. Very good yields have been secured on the heavy clay lands similar to those in Outagamie County, but the difficulties of growing and harvesting are much greater than on lighter soils.

In regard to root crops, carrots and rutabagas do better than mangles or beets on the light soils. Excellent yields of mangles and beets have been secured on the Superior clay loam. Monarch rutabagas have yielded on an average of 24.57 tons an acre, and the Bangholm rutabagas yielded 21 tons an acre. The Mammoth long red mangle yielded 17.49 tons an acre, and sugar beets yielded 17.87 tons an acre.

The various types of farming are also influenced by soil conditions, and the dairy industry is most highly developed in the region of heavy soils. Agriculture is less developed in the portions of the county where the soils are of a sandy nature.

ROTATION OF CROPS.

In discussing rotations, farm crops may be divided into three classes:

1. Grain crops—generally shallow feeders, add little humus or organic matter, and tend to weediness.

2. Hay crops—legumes, timothy, etc. Legumes have extensive root systems, tap roots, add organic matter or humus and also plant food (nitrogen). They also improve the physical condition of the soil.

3. Cultivated crops—corn, potatoes, etc., conserve moisture, favor decomposition of organic matter, and destroy weeds. Some are deep feeders, as corn, while root crops are shallow feeders.

A good rotation should necessarily include crops belonging to each of these three classes. The value of such practice is apparent in its effect on the physical condition of the soil, on weediness, on organic matter supply, on plant diseases, and on nitrogen supply of the soil. Better yields are, therefore, obtained when crops are rotated than when a single cropping system is followed.

Again, crop rotation permits raising livestock and means diversified farming. No one will deny the benefits of this type of farming in stabilizing farm business and making best use of labor and equipment the year around.

It should not be understood, however, that crop rotation means maintaining the supply of plant food better than where a single cropping system is practiced. It is often said that certain crops are "hard" on the soil in the sense that they remove more plant food than other crops. In part that is true, but a more important difference is that some plants remove more of certain elements than others. Again, a crop like corn, because of its root development and length of growing season, may utilize plant food that is less soluble.

Potatoes require relatively more potassium; corn draws heavily on nitrogen; while legumes are heavy feeders of lime (calcium) and also require large amounts of phosphorus, potassium, and nitrogen (some of which may be extracted from the air in the soil). Again, grain crops and roots require plant food that is readily available, while corn is less particular in this respect.

By properly rotating crops, therefore, the soil is subjected to these different "feeding characteristics". One crop compensates for the other, and there is maintained more nearly a balanced condition than with the single crop system.

It is of great importance that in selecting crops to grow, careful consideration be given to the question of climate. This is about the only factor which the farmer cannot control. A poor soil may be improved, better markets may be found, and better labor secured; but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other

hand, the same variety of corn requires a shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

There is no one best system of rotation.* The rotation depends on the system of farming, and this depends largely on the personal choice of the farmer, for some prefer one system and some another. It is highly desirable to rotate crops, but a serious mistake to think that rotation takes the place of other equally sound practices, such as liming and fertilizing.

Following are a few suggestions regarding the selection of rotations for Outagamie County.

1. Rye.
2. Barley, oats, or spring wheat seeded to clover.
3. Clover.
4. Cultivated crop.
5. Peas.

This rotation has been worked out at the Experiment Station Farm at Madison. The following rotation has been worked out at the Experiment Station on sandy soils:

1. Rye, sown as soy beans.
2. Clover.
3. Corn or potatoes.
4. Soy beans.

Other rotations suited to heavier soils consists of

1. Corn.
2. Oats or barley.
3. Clover.
4. Winter wheat seeded to clover.
5. Clover.
1. Clover.

*See Bulletin 222, 347 Wis. Exp. Station.

2. A cultivated crop.
3. Peas.
4. Winter wheat seeded to clover.

A three-year rotation which is quite commonly used is a cultivated crop, followed by a small grain, followed by clover. This may be changed to a four-year rotation by planting timothy and clover, and cutting hay for two years. This may be changed to a five-year rotation by following mixed hay with peas, and then following peas with a cultivated crop. Potatoes fit in well with a rotation, and in the sandy sections may be grown in rotation with small grain and clover; the second crop of clover is plowed down to supply organic matter.

On the marsh lands as they are reclaimed the question of crop rotation should also be considered. There are three types of farming to which marsh soils are adapted, and these are stock raising or dairy farming, trucking or a combination of the two in which neither type predominates. Grain farming cannot as yet be recommended on marsh soils. Where a farmer has thirty or forty acres of peat he can divide the field into four parts and raise cabbage on one, sugar beets on one, grain on one, and hay on the other. Thus a four-year rotation of hay, sugar beets, cabbage and grain would be practiced on the peat. On a dairy farm, two or three crops of corn may be grown in succession but in this region one should take into account the danger from frost. The corn may be followed by grain, and this by clover and timothy. The hay may be cut the first year and pastured the second. Potatoes may also be grown on peat land but here again the danger from frost must be considered. In some localities outside of this area in this and other states, a one-crop system is being followed where celery, peppermint, or some other crop is the entire source of income. While a rotation of crops on such land is not absolutely essential, a change of crops is desirable to aid in the control of weeds and insect pests.

FARM EQUIPMENT.

Agriculture in Outagamie County is highly developed, and the farm buildings over most of the area reflect the prosperous condition of the farm population. Large, well-painted barns equipped with modern appliances for the handling of dairy cattle, are common throughout the Fox River Valley, and the region covered by the Superior soils. The houses are well con-

structed and painted; many of them are supplied with electric lights, telephone, and rural mail service. In 1920 there were 2,043 silos and 343 tractors in Outagamie County. In the more sandy and less developed sections of the county represented by the districts in the central and north central part, the farm buildings are not so well constructed, neither are they kept in as good repair, as in the Fox River Valley. Even in this region, however, the condition may be considered fair; and it may be said that the fertility of the soil is reflected in the character of the buildings and equipment on each farm.

FARM TENURE AND LABOR.

In 1920 there were 3,746 farms in Outagamie County, the average size of which was 92.9 acres. Of this number of farms only 688 are operated by foreign born farmers; 84.1 per cent of the land in the county is in farms, and of the land in farms 68 per cent is improved. There are on each farm an average of 63.2 acres of improved land.

Of all the farms, 90.81 per cent, or 3,400 farms, are operated by the owners, 42 by managers, and 304 are operated by tenants. Of the farms which are rented, somewhat more than 50 per cent are on a cash rental basis, and the remainder on a share basis.

The census of 1920 reported 2,271 farms in the county upon which there was a mortgage debt. The same report indicated that 1,039 farms were free from mortgage debt. There was no report on a number of farms.

The supply of farm labor is fairly good. In many cases women and children assist in farm work. When men are hired by the year or month, the wage ranges from \$40.00 to \$70.00 a month, depending on the experience of the man. Married men are usually given a house in which to live as well as fuel and a garden. During harvest and haying times when extra labor is often needed, the wages are somewhat higher than this, when engaged by the day.

METHODS.

In general, the methods of farming which are followed are practically the same as those practiced throughout the general farming and dairying sections in Wisconsin. The silo is in common use, and about 60 per cent of the corn crop is handled

as ensilage. The hay crop is usually stored in the barn or stacked, and used mainly as feed for stock. In the production of crops, modern machinery is in use, and the tractor is quite common in most parts of the county. It is considered desirable to plow heavy land in the fall if it is possible to do so, but on light, sandy soils spring plowing is preferable. On almost all farms a rotation of crops is practiced, although not always the one which is best suited to conditions prevailing on the farm.

The heavy soils of the Superior series require careful tillage and must be plowed when the moisture conditions are most favorable in order to prevent the formation of clods. Heavy tools and work stock are needed on this land, but when cultivated under proper conditions but little difficulty is experienced in securing a good seed bed.

In the cultivation of marsh soils which are beginning to be improved, the use of a roller for compacting the peat is very important. The roller is also an implement which can be used to advantage on the sandy soils; and the corrugated roller is especially desirable.

LIMING.*

Outagamie County lies in part within the glaciated limestone region of Wisconsin, and a considerable proportion of the soils have been derived in part from limestone material. The subsoil of most of the types is well supplied with lime, and the surface of the soil in many places is neutral or only very slightly acid; in fact, many tests for acidity have been made where the soil does not show any reaction whatever. The types which are most apt to show an acid reaction are soils of the Antigo series, Whitman series, Coloma series, and the peat soils. Where the peat is surrounded by soils of the Superior series, the least acidity in marshes is found.

The degree of acidity is somewhat variable, and each farmer may find a variation in acidity on his farm. It is essential, therefore, that every farm should have his various fields tested before making an expenditure for lime. The county agent can do this, or samples may be sent to the Soils Department of the University where free tests will be made. Failure of clover and alfalfa or a growth of sorrel may be an indication of acidity.

*See Bulletin No. 312 Wisconsin Experiment Station.

About two tons of ground limestone per acre is the usual application where soils show slight to medium acidity. The amount to be used, however, may vary with the degree of acidity, the character of the soil, and the crop to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement. Clover, garden beans, barley, hemp, turnips, and radishes have a medium lime requirement, while vetch, white clover, oats, rye, blue grass, potatoes, sorghum, and others have a low requirement for lime.

Ground limestone is doubtless the most economical form of lime which can be extensively utilized in Outagamie County. Lime should be applied previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter, or spring applications may be made on heavy soils, but on light soils spring application is preferable.

The best way to apply lime is with a regular spreader made for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for this purpose.

After making a first application of two tons per acre, it is not likely that another application will be needed for four to six years, and the need should again be determined by soil acidity tests, as well as by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason, it is important that both deficiencies should be corrected to secure the most economical production.

DISTRIBUTION OF LIME, COMMERCIAL FERTILIZER AND MANURE.*

Phosphate or other fertilizers or lime should be uniformly distributed. Ground limestone is applied at the rate of from 2,000 to 4,000 pounds or more an acre, while with phosphates and other fertilizers the amount applied for staple crops is usually from 75 to 400 pounds. It is difficult to construct a machine which will satisfactorily distribute both fertilizer and limestone, although excellent machines are on the market for distributing each separately. The fertilizer distributor may be a part of a grain drill or a separate machine. The machine for distributing ground limestone should be provided with a double agitator so as to secure continuous feeding.

End gate seeders which will distribute proper amounts of either fertilizer or ground limestone fairly well are available.

When a fertilizer distributor is not available the acid phosphate or other fertilizer may be spread evenly over the manure in the manure spreader, and so receive a very fair distribution. This method will give very good results until such time as a grain drill with fertilizer attachment can be purchased. The amount to be applied on each spreader load must be calculated so the right amount per acre will be applied. An old drill or seeder may also be used to distribute the fertilizer going ahead of the grain drill.

The care and use of the manure produced is an important factor in the management of dairy and stock farms. The chief advantage of these types of farming is that the proper use of the manure or other waste products makes it possible to maintain profitable yields with comparatively little purchased fertilizer. But it is only when intelligent care is taken that this result is possible. Much of the available plant food in manure is readily soluble in water, so that if the manure is exposed to the rain in flat or shallow piles, a considerable part of its value is lost. This affects nitrogen and potash especially. It is important also to recognize that a large portion of this element is in the liquid part of the manure and that it is necessary, therefore, to use bedding or absorbents freely to prevent a considerable loss. This is particularly true of potash, about 60 per cent of which is contained in the liquid manure.

*For detailed information on the use of commercial fertilizers see bulletins of the Wisconsin Experiment Station.

Ordinarily the best practice is to haul the manure directly to the field. When this is not practicable the pile should be kept compact, well trodden and moist, as it can be through the use of slightly saucer-shaped manure pit, from the outer sides of which the ground slopes away so as to prevent water washing into the pit itself. In this climate the use of shelter is of doubtful importance, though where more rains occur, particularly in the winter, a shed roof is very helpful.

The rate and frequency with which manure is applied depends in part on the character of the soil on the farm. On lighter soils more frequent applications of small amounts are desirable than on heavier soils. Five or six loads per acre every third year is desirable on the sandy loams, while eight to twelve or more every fourth or even fifth year may be used to advantage on heavier soils.

DRAINAGE.*

Outagamie County has approximately 115,000 acres of land which the soil survey has classed as poorly drained, and which must be provided with some form of drainage before cultivated crops can be grown safely from year to year. Of this poorly drained land, approximately 50 per cent consists of peat, nearly 15,000 acres consists of overflow land classed as Genesee, and the remainder consists of low, poorly drained mineral soils, belonging to the Poygan, Whitman, and Clyde Series. This estimate does not include the Superior clay loam which is a level, heavy soil, needing drainage in places.

The largest areas of undrained land occur in the northwestern quarter and the west central parts adjoining the Wolf, Embarrass, and Shioc Rivers.

At the present time, there are approximately eighteen thousand acres of poorly drained land in operating drainage enterprises. Of this, 5,468 acres are classed as improved, but only 2 to 3 per cent of this improved land is actually in farms. There are 68.4 miles of open ditches with six additional miles under construction. The amount of capital invested in enterprises which have been completed or which are under construction amounts to \$167,540.

*Those who are interested in drainage should apply to the Wisconsin Experiment Station for more specific information concerning their individual problems. Several drainage bulletins are available.

The type of low land which offers the greatest opportunity for drainage is included in the Poygan, Whitman, and Clyde Series. These types of land when thoroughly drained will all make excellent farm land, and conditions are such that most of this land can be reclaimed at a cost which will make the development profitable. The peat soils, on the other hand, require much more careful cultivation and fertilization after drainage, and much of this land also lies tributary to large streams which are sluggish in their movement, and the lowering of which is frequently necessary before the adjoining peat land can be thoroughly drained.

The drainage of some of the peat, therefore, offers obstacles greater than the drainage of the heavier soils. There are considerable areas of peat land, however, which can be readily drained, and on which drainage enterprises are now under way. The completion of these various drainage enterprises will add a large acreage to the tillable land within the county.

Most of the marsh land within the county is still unimproved, and the chief use which is being made of it is for pasture and to some extent for marsh hay.

Where areas of low land include several farms, the owners can readily form a drainage district, and sell bonds to pay for the improvement. This is the method which has been used, and a number of drainage districts have already been established in the county. In this way, the cost of the drainage can be spread over a number of years, and can actually be paid for from the products of the improved acres. Assistance in the development of such projects can, and in fact must, be secured from the state authorities, who pass upon the possibility of the project before the state permits the organization of a drainage district. Where the areas of marsh land are small and confined to one farm, and where there is sufficient outlet, the farmer can install his own tile system without the co-operation of adjoining land owners. This has been done on a number of occasions, yet there are thousands of acres in small tracts which have not been improved.

For a more detailed discussion of drainage, see bulletins 284 and 309, Wisconsin Experiment Station.

CLIMATE.

The climate of Outagamie County is typical of that of east-central Wisconsin. It is healthful, though subject to extreme changes in temperature. The winters are long and severe. The thermometer frequently falls as low as -20° F. The ground freezes to a depth of 1 to 3 feet. Snow usually remains on the ground from December to March or later and protects such winter crops as clover, alfalfa, and wheat. The summers are comparatively short, but pleasant. The thermometer sometimes reaches 100° F. or more. The highest temperature recorded at New London is 104° F., but such extremes are rare. The hottest periods during the summer months seldom continue for more than a few days, and it is unusual for the temperature to remain below zero for more than a week at a time during the winter.

The average rainfall of 32.68 inches is distributed throughout the year, although the precipitation is heaviest during the growing season and lightest in the winter. The average for the summer months of June, July and August is 11.63 inches.

The average date of the last killing frost in the spring, as recorded at New London, is May 10, and that of the first in the fall, September 25. This gives an average growing season of 138 days. The length, however, varies somewhat in different parts of the county, and in the southeastern part of the county, in the region of the Fox River, the season may be 5 to 10 days longer. Killing frost has been recorded at New London as late in the spring as June 12 and as early in the fall as August 30.

In the following table are given the more important climatic data as recorded by the Weather Bureau station at New London :

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT NEW LONDON.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute Maxi- mum.	Absolute mini- mum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1916).
	° F.	° F.			Inches.	Inches.
December.....	20.5	53	-25	1.39	0.82	0.73
January.....	15.4	52	-31	1.10	1.16	2.89
February.....	16.1	50	-37	1.28	.84	1.23
Winter.....	17.3	53	-37	3.77	2.82	4.85
March.....	29.6	82	-18	2.04	.12	1.79
April.....	41.5	87	8	2.69	5.89	2.27
May.....	56.1	91	20	1.41	1.63	5.35
Spring.....	43.4	91	-18	9.14	7.64	9.41
June.....	65.8	104	32	3.94	1.16	6.81
July.....	70.4	102	41	4.35	.78	1.70
August.....	67.9	97	33	3.34	2.78	3.78
Summer.....	68.0	104	32	11.63	4.72	12.29
September.....	60.5	97	19	3.67	4.83	6.40
October.....	48.8	85	14	2.50	1.30	4.75
November.....	33.6	71	-14	1.97	2.34	2.70
Fall.....	47.6	97	-14	8.14	8.47	13.85
Year.....	44.1	104	-37	32.68	23.65	40.40

SUMMARY.

Outagamie County is situated in the east central part of Wisconsin, between Lake Winnebago and Green Bay. It has an area of 646 square miles, or 413,440 acres.

All of the county drains directly or indirectly into Green Bay. The southeastern corner is traversed by the Fox River, which flows directly into Green Bay. The western part of the county is crossed by the Embarrass, Shioc and Wolf Rivers, the waters of which find their way into Lake Winnebago, and then through the Fox River into Green Bay. The first-named streams are rather sluggish, but the Fox River in a distance of 35 miles has a fall of 170 feet. Many large manufacturing establishments use power developed from this stream.

Farm operations in this county followed closely upon the removal of the timber. All parts of the county are well improved. The northwestern part, which contains considerable areas of Peat marshes and some tracts of sandy soil, is least developed.

All parts of the county are well supplied with railroads, and the wagon roads throughout the county are generally in good condition. Under a State Highway improvement law many gravel and crushed-rock roads are now being constructed. A system of concrete roads, which will ultimately connect the county seat with practically all towns in the county, is one of the most important road projects.

The soils of Outagamie County have been derived from glacial, lacustrine, and alluvial material. In addition, there are large deposits of Peat, consisting of partly decayed organic matter. The soils are classified into 10 series and 24 types, exclusive of Peat.

The Superior series include light-brown soils with heavy, red clay subsoils, occupying areas where the surface is level to rolling. The fine sandy loam, loam, silt loam, and clay loam are mapped in this survey.

The Poygan series consists of dark-colored, low lying, poorly drained soils having heavy, red clay subsoils. In this county the fine sandy loam, silt loam and clay loam are mapped.

The Coloma series includes the light-colored, light textured soils which have been derived through glacial action largely from sandstone. The Coloma fine sand and fine sandy loam are mapped in this county.

The Antigo series consists of light-colored soils which occupy outwash plains or stream terraces where the material has come mainly from crystalline rocks. The types mapped in this survey are the fine sandy loam and loam.

The Plainfield fine sand is similar to the Antigo soils except that it has been derived largely from sandstone material.

The Miami fine sandy loam and loam are light-colored upland soils derived chiefly from glaciated limestone material.

The Whitman series is similar to the Antigo except that the soils are dark colored and contain much larger amounts of organic matter. They are often acid. The types mapped are the fine sandy loam and loam.

The Clyde series consists of low-lying, dark-colored soils occupying old lake beds or stream valleys where the soil material has come largely from glaciated limestone. They are similar to the Whitman soils except that they contain considerable lime carbonate and are very seldom acid. The members of the Clyde series mapped are the fine sandy loam, till phase, and the silt loam, till phase.

The Genesee series consists of brown soils which occupy first bottoms along streams in the glaciated region. They are subject to overflow. The fine sandy loam and silt loam are mapped in this county.

In addition to the above soils, extensive areas of Peat are mapped in Outagamie County. Peat consists of decaying vegetable matter with which there has been incorporated a very small amount of fine mineral particles.

Agriculture in this county consists chiefly of general farming, with dairying as the most important branch. The chief crops grown are hay, oats, corn, barley and rye. Smaller acreages are devoted to such crops as potatoes, cabbage, sugar beets and buckwheat.

Dairy products find their way to market chiefly in the form of butter and cheese. In 1917 there were produced in this county over 9½ million pounds of cheese. There are 21 butter factories and 86 cheese factories in the county.

Holstein cows are most numerous in the dairy herds and all the dairy stock is gradually being improved.

In 1920 there were a total of 3,746 farms in the county, of an average size of 92.9 acres. About 91 per cent of the farms were operated by the owners.

Well-located and highly improved farms have a selling price at present of \$150 to \$250 an acre. Rather sandy soils of low agricultural value have a selling price of \$20 to \$50 an acre, depending upon the location, improvements, soil condition and other factors.

The climate of Outagamie County is representative of a large section of eastern Wisconsin. The mean annual rainfall is 32.7 inches. The average length of the growing season as recorded at New London is 138 days.

